

CLEARWATER

G R O U P

Environmental Services

June 16, 2005

Mr. Mark Verhey, P.G.
Humboldt County Division of Environmental Health
100 H Street, Suite 100
Eureka, CA 95501

RE: Bi-annual Geochemical Survey Report – A Comparison with Pre-Remediation Background Levels.

Jean and Everett Seymour Property
1111 Riverside Drive
Rio Dell, California
LOP# 12032
Clearwater Project AE001D

Dear Mr. Verhey:

Clearwater Group (Clearwater) is pleased to submit the results of the bi-annual geochemical study at the subject property. This Geochemical Study was performed to assess the performance of an in-situ bioremediation system (iSOC system) that has been operating since October 6, 2005. This report will compare the microbial and chemical parameters from the 6-month sampling event (sampled on 4/18/05) with pre-remediation background levels.

A summary of the various indirect geochemical indicators is included in Table 1. All laboratory reports are attached to this document. This report was prepared by Clearwater Group based on the results of microbiological laboratory data from CytoCulture International, Inc., and additional chemical laboratory work done by Alpha Analytical Labs, Inc. of Ukiah, California.

iSOC SYSTEM INSTALLATION

In October 2004, Clearwater oversaw the installation of an iSOC system in MW-1. The iSOC oxygen infuser was installed in MW-1 and was connected to a central regulated oxygen gas supply. The iSOC unit is suspended in the well, approximately 0.5 feet above the bottom, using plastic-lined cord, which is hung from the well plug. The oxygen supply is connected to the individual well and the infuser via underground plastic tubing.

The oxygen feed pressure to the well ranges between 3.5 psi and 5.0 psi. The gas flow rate to the well was 20 cc/min.

TESTING PARAMETERS EXPLANATION

Site characteristics that were recorded include hydraulic conductivity and soil structure, groundwater mineral content, groundwater pH, groundwater temperature, microbial presence, terminal electron acceptors, and nutrient concentrations. Constituent characteristics include chemical structure, concentration and toxicity and solubility.

FIELD PARAMETERS

Dissolved oxygen (DO) identifies aerobic and anaerobic regions of contaminated site and the chemical, physical and biochemical activities occurring. A low dissolved oxygen level can limit the bacterial metabolism of certain organic compounds.

Abnormally low levels of DO might indicate the presence of not only hydrocarbons, but also other organic material. The oxygen demand reflects chemical and biological reactions that are measured as biological oxygen demand (BOD), chemical oxygen demand (COD) and solid oxygen demand (SOD). The hydrocarbons and organic material would decompose in situ and consume the available oxygen. .

Without adequate oxygen (e.g., at least 2-3 parts per million), the rates of aerobic biodegradation would be inhibited and the TPH contaminant concentrations would remain in equilibrium with the desorption of petroleum hydrocarbons from contaminated soil in contact with the water.

At the pre-remediation stage, the DO at the subject property was between 3.0 mg/l (MW-2; clean upgradient well) and 0.4 mg/l for MW-1. Monitoring well MW-1 is within the core of the plume or at the center of the "hot spot". Since the iSOC unit has been in operation, DO readings have increased significantly in MW-1 to 24.9 mg/l. DO levels remained stable in MW-2. These measurements were performed on-site using a calibrated Point-Four Dissolved Oxygen meter.

Oxidation Reduction Potential (ORP) is a measure of the REDOX potential or the ability to donate electrons (hydrogen and a large variety of organic and inorganic chemicals) and accepting electrons such as oxygen or other terminal acceptors; nitrate, nitrite, sulfate, carbon dioxide, iron (III), manganese (IV); (Suthersan, 2002). Negative redox potential suggest anaerobic environments and anaerobic degradation pathways. Highly negative (-100 millivolts) are required for methanogenesis and PCE/TCE biodegradation. Highly positive (+100 to +200 mV) are indicative of aerobic conditions.

The ORP range at the pre-remediation phase was +63 to +81 mV for MW-1 and MW-2, respectively. At the 6-month sampling event, ORP ranged from +45 to +58 mV for MW-2 and MW-1.

pH is a measure of the acidity or alkalinity of water. A change in pH may be associated with microbial activity. The groundwater in monitoring wells MW-1 and MW-2 had pH readings ranged from 6.59 and 7.43, respectively, at the pre-remediation sampling event, well within the range of acceptable pH for aerobic biological activity. At the 6-month sampling event, pH remained within the acceptable range of 5.70 and 6.24 for MW-1 and MW-2, respectively. Although readings of less than a pH of 4.00 or greater than 9.00 are generally unfavorable for microbiological activity. Optimal microbial activity occurs under neutral pH conditions of 6 to 8 range. Because indigenous microbes have adapted to the natural conditions where they are located, pH adjustment is generally not recommended initially since it may inhibit microbial activity. For acidic waters (5 or less), lime or sodium hydroxide can be added to increase pH. For groundwater with excessive pH (greater than 9), hydrochloric acid can be added to reduce the pH. Changes in pH should be monitored closely. Rapid changes of more than 1 to 2 pH units can inhibit microbial activity and may require an extended acclimation period prior to the resumption of full microbial activity levels. A more acidic pH value suggests more extensive biodegradation of other organics or prior biodegradation of higher concentrations of petroleum hydrocarbons.

Total iron and **ferrous iron** (Fe^{+2}) is measured in the field using colorimetric field kits. These kits were used on-site to evaluate the condition and amount of the dissolved iron in the aquifer. By subtracting ferrous iron from total iron, the amount of ferric iron (Fe^{+3}) can be established. Ferrous iron is soluble iron in the reduced state. Ferric iron, as measured in solution is in the oxidized state. Ferric iron in the solid form is commonly called rust.

During the pre-remediation sampling event, ferrous iron was detected in MW-1 at 3.2 mg/l. Reduced iron was not detected in MW-2. Total iron for MW-1 and MW-2 ranged from 4.2 to 0.4 mg/l, respectively, and is within the normal range for dissolved iron in this part of northern California. The percentage of ferrous iron (reduced form) as a percent of total iron is as follows: MW-1 (76%), and MW-2 (0%). The higher percentage of ferrous in the core of the "hot spot" corresponds well with the hydrocarbon concentrations and anaerobic conditions. As dissolved oxygen is added to the system, ferrous iron will decrease over time. Samples within aerobic zones tend to have very low or ND concentrations of ferrous iron. At the 6-month sampling event, a decrease in ferrous iron was observed in MW-1 (0.4 mg/l). MW-2 levels remained below detection levels. Total iron decreased in both MW-1 and MW-2 to 2.2 and 0.2 mg/l, respectively. The percentage of ferrous iron (reduced form) as a percent of total iron decreased significantly in MW-1 to 18% indicating that the environment is oxidizing as predicted.

Conductivity is a good measure of the total amount of salts in solution. These salts include calcium, magnesium, sodium, potassium, chloride, and others. At the pre-remediation sampling event, conductivity for MW-1 and MW-2 was 2.61 and 4.94 mS/cm, respectively. No significant change was reported at the 6-month event, MW-1 and MW-2 conductivity levels were 2.48 and 3.55 mS/cm, respectively.

LABORATORY PARAMETERS

MICROBIAL STUDY

Most soils contain large numbers of diverse microorganisms, including bacteria, algae, fungi, protozoa and actinomycetes (U.S. EPA, 1995). Of these, bacteria are the most numerous and biochemically active group, particularly at low oxygen levels, and they contribute significantly to in-situ groundwater bioremediation. The following tests are conducted to assess microbial activity.

Heterotrophic Plate Count is used to determine the number of microbial units within the liquid or soil sample. The result is calculated in Colony Forming Units. It is an excellent way to show that biodegradation is occurring. Total heterotrophs in MW-1 and MW-2 were 2×10^3 cfu/ml for both wells at the pre-remediation sampling event. After 6-months of iSOC operation, the total heterotrophs increased in both MW-1 and MW-2 by one order of magnitude to 3×10^4 cfu/ml and 2×10^4 cfu/ml, respectively.

Specific Hydrocarbon Degraders indicate the colony forming units of the microbes that specifically target the gasoline/diesel as a food source. At the pre-remediation event, the specific degraders in well MW-1 and MW-2 were 2×10^3 cfu/ml for both wells, indicating that all the heterotrophs were of the hydrocarbon degrading bacteria type. This indicates that with proper conditions, the microbes are plentiful and well adjusted for this environment.

Once oxygen is added to MW-1, increases in specific degraders and total heterotrophs in MW-1 should be observed above the background levels noted above. Results from the 6-month sampling event indicate that specific degraders have increased in MW-1 to 2×10^4 cfu/ml as expected. A small increase was observed in MW-2 (3×10^3 cfu/ml).

CHEMICAL ANALYSES

Total Dissolved Solids (TDS) defines the concentration of dissolved organic and inorganic chemicals. TDS is within the normal range. Typically, microbial activity creates more turbidity. TDS defines the concentration of dissolved organic and inorganic chemicals. The dissolved solids, commonly found are calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, and silica. TDS should increase with microbial activity after the addition of terminal electron acceptors, such as oxygen. TDS was

measured at 170 mg/l in MW-1. TDS was not measured in MW-2. At the 6-month sampling event, TDS remained stable in MW-1 at 170 mg/l. MW-2 reported TDS at 220 mg/l. No comparison was possible as TDS was not measured at the pre-remediation event.

Total Inorganic Carbons (TIC) is the best overall indicator of aerobic biological activity (by measuring the generation of CO₂). TIC includes free carbon dioxide (dissolved) in the groundwater, carbonate ion, bicarbonate ion and carbonic acid. As the petroleum hydrocarbons are being broken down by biological activity, the inorganic carbon should increase while the organic carbon should decrease, with declining hydrocarbon concentrations. TIC can be measured using laboratory equipment, as it was in this case, or by analyzing total alkalinity and obtaining TIC by calculation. TIC was detected at 22.2 mg/l in MW-1 and 10.4 mg/l in MW-2 at the pre-remediation sampling event. Results from the 6-month event report TIC levels in MW-1 at 10.3 mg/l and MW-2 at 28.1 mg/l.

Alkalinity is the combination of carbonate and bicarbonate ion concentrations in the water. As these ions are inorganic, alkalinity is a partial analysis of total inorganic carbon, which is used as an indicator of biological activity. Alkalinity was measured at 130 mg/l in MW-1 and was not measured in MW-2. At the 6-month sampling event alkalinity ranged from 39 mg/l in MW-1 to 87 mg/l in MW-2.

Bicarbonate Ion, Carbonate Ion, Carbon Dioxide and Carbonic Acid are dissolved components of the speciated alkalinity reading. The site contains alkalinity that is totally the bicarbonate ion. The carbonate ion, carbonic acid and carbon dioxide were not detected above laboratory reporting levels. Bicarbonate was measured at 130 mg/l in MW-1 and was not measured in MW-2. All the alkalinity in MW-1 is associated with the bicarbonate ion. Carbonate and hydroxide were below reporting levels for MW-1, and these parameters were not measured in MW-2. At the 6-month event, the alkalinity readings were still totally represented by the bicarbonate ion.

Hydroxide alkalinity is the alkalinity measurement of all material above pH 8.13. In this case, the pH for all samples was below the 8.13 threshold, so hydroxide concentration is listed on the laboratory reports as "non-detect". There was no hydroxide alkalinity detected on the site.

Nitrate (NO₃) is an alternate electron acceptor used by various microbes after oxygen is consumed. At the Subject Property during the pre-remediation sampling, all nitrate analyses are listed on the laboratory reports as "non-detect". This means that there was never nitrate in the system or that the nitrate has been consumed as an alternate terminal electron acceptor by the microbes as the oxygen concentrations have decreased to below usable levels. Under anaerobic conditions, facultative bacteria will use nitrate or sulfate as other alternative terminal electron acceptors in the electron transport chain that leads to

the production of ATP in the absence of oxygen. Results from the 6-month sampling event report an increase in nitrate levels to 58 mg/l in MW-1 and 57 mg/l in MW-2. This increase can be explained by the inflow of up-gradient groundwater with natural nitrate concentrations to the remediation area. Due to the increased oxygen now available in this area, nitrate is no longer the terminal electron acceptor and therefore nitrate concentrations are observed at background levels.

Sulfate (SO₄) is an alternate electron acceptor used by various microbes after oxygen, nitrate and iron/magnesium are consumed. The sulfate level at the site for MW-1 was 3.1 mg/l. The high concentrations of hydrocarbons in MW-1 are associated with the relatively low (consumed) sulfate levels. A typical aerobic zone or uncontaminated area of a site might have sulfate levels in the range of 50 to 200 mg/l. After 6-months of iSOC operation, sulfate levels increased to 18 mg/l at MW-1 and 22 mg/l at MW-2.

NUTRIENTS

o-phosphate and ammonia as nitrogen are essential to microbial growth. Nutrient concentrations at the Subject Property are quite low or depleted. At the pre-remediation phase the ammonia as nitrogen and orthophosphate concentrations at the site for MW-1 and MW-2 were below laboratory reporting levels, or "ND". These levels of both nutrients are depleted or ND, indicating that nutrients are not at optimal levels. At the 6-month sampling event, ammonia as nitrogen and orthophosphate concentrations for MW-1 and MW-2 were still below laboratory reporting levels, or "ND".

The addition of the nutrients into the subsurface is quite simple. However, nutrient addition would only be recommended if higher TPH concentrations (>5,000 ug/l) were observed.

OXYGEN DEMAND

Biological Oxygen Demand (BOD) measures the amount of oxygen consumed by microorganisms while they are decomposing organic matter. The BOD on the site for MW-1 was 30 mg/l in August 2004. MW-2 was not analyzed for this study. The addition of dissolved oxygen should help to reduce the competing reactions, which also want the oxygen, lowering BOD over time. The BOD₅ test is 5-day analyses typically done for sewer treatment plants. BOD is a subset of COD. After 6 months of iSOC operation, BOD levels have decreased to non-detect levels for both MW-1 and MW-2. The reduction of BOD indicates an increase of DO in the aquifer.

Chemical Oxygen Demand (COD) measures the amount of oxygen consumed by chemical and biological demands. The COD on the site for MW-1 was 110 mg/l in August 2004. MW-2 was not analyzed for this study. The addition of dissolved oxygen should help to reduce the competing reactions for oxygen, lowering COD over time. COD was measured at the 6-month sampling event, concentrations in MW-1 were at 57

mg/l. MW-2 COD levels were non-detect. The reduction of COD indicates an increase of DO in the aquifer.

CONCLUSIONS

- The operation of the iSOC unit in MW-1 has converted the environment from anaerobic to aerobic.
- Specific degraders have increased significantly with the increased O₂ levels.
- Sulfate and nitrate levels have increased to probable background levels now that oxygen is available as the terminal electron acceptor.
- BOD and COD have decreased since the initial pre-remediation sampling event, indicating that the oxygen demand is being satisfied.
- Total iron has decreased in MW-1. The percentage of ferrous iron (reduced form) as a percent of total iron decreased significantly in MW-1 from 76% to 18% indicating that oxidation has increased as predicted.
- A significant decrease in petroleum hydrocarbon concentrations has been observed in MW-1. These decreases may be due to seasonal water elevation fluctuations.
- Nutrient levels (o-phosphate and ammonia as nitrogen) are still at low concentrations.

RECOMMENDATIONS


- In the fourth quarter 2004 and first quarter 2005 groundwater sampling events, petroleum hydrocarbon concentrations have been at non-detect levels in MW-1. This was a marked decrease from pre-remediation levels. This reported decrease may be the result of the increase in groundwater levels. Therefore, a more accurate evaluation of possible decreases in petroleum hydrocarbon concentrations should be conducted when the groundwater is at the seasonal low.
- The iSOC system should continue operation and indirect geochemical indicators should be reevaluated on a bi-annual basis.
- Even though nutrient levels are at low concentrations the addition of nutrients is not recommended. Nutrient addition would only be recommended if higher TPH concentrations (>5,000 ug/l) were observed.

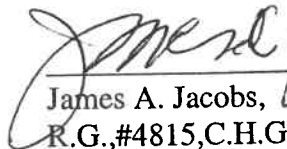
CERTIFICATION

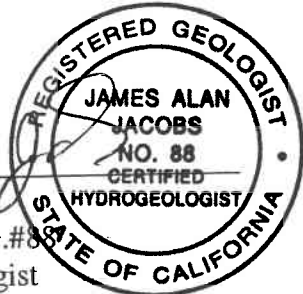
This report was prepared under the supervision of a Professional Geologist in the state of California at Clearwater Group. All statements, conclusions and recommendations are based solely upon published results from previous consultants, field observations by Clearwater Group and laboratory analysis performed by a California DHS-certified laboratory related to the work performed by Clearwater Group. Clearwater Group is not responsible for laboratory errors. The information and interpretation contained in this document should not be relied upon by a third party. The service provided by Clearwater Group has been conducted in a manner consistent with the level of care and skill ordinarily exercised by members of our profession currently practicing under similar conditions in the area of the site. No other warranty, expressed or implied, is made.

Sincerely,

Clearwater Group


Matthew Ryder-Smith
Project Manager


James A. Jacobs,
R.G., #4815, C.H.G. #88
Chief Hydrogeologist



Attachments:

Table 1 – Summary of Indirect Indicators
Alpha Analytical Laboratory Report
CytoCulture Laboratory Report
Clearwater Bottle Sampling Protocol

TABLE 1 - INDIRECT GEOCHEMICAL INDICATORS
CUMULATIVE GROUND WATER SAMPLE RESULTS (mg/L)

WELL	DATE	Specific Hydrocarbon Degraders (cfu/ml) microbes	Target Hydrocarbons Detected	Total Heterotrophs (cfu/ml) microbes	Alkalinity total (CaCO ₃) mg/l	Bicarbonate (CaCO ₃) mg/l	Carbonate (CaCO ₃) mg/l	Carbon Dioxide (CO ₂) mg/l (calc)	Hydrides mg/l
MW-1	8/4/2004	2 X 10 ³	Gasoline/Diesel	2 X 10 ³	130	130	ND	NA	ND
MW-1	4/18/2005	2 X 10 ⁴	Gasoline/Diesel	3 X 10 ⁴	39	39	ND	NA	ND
MW-2	8/4/2004	2 X 10 ⁵	Gasoline/Diesel	2 X 10 ⁵	NA	NA	NA	NA	NA
MW-2	4/18/2005	3 X 10 ³	Gasoline/Diesel	2 X 10 ⁴	87	87	ND	NA	ND

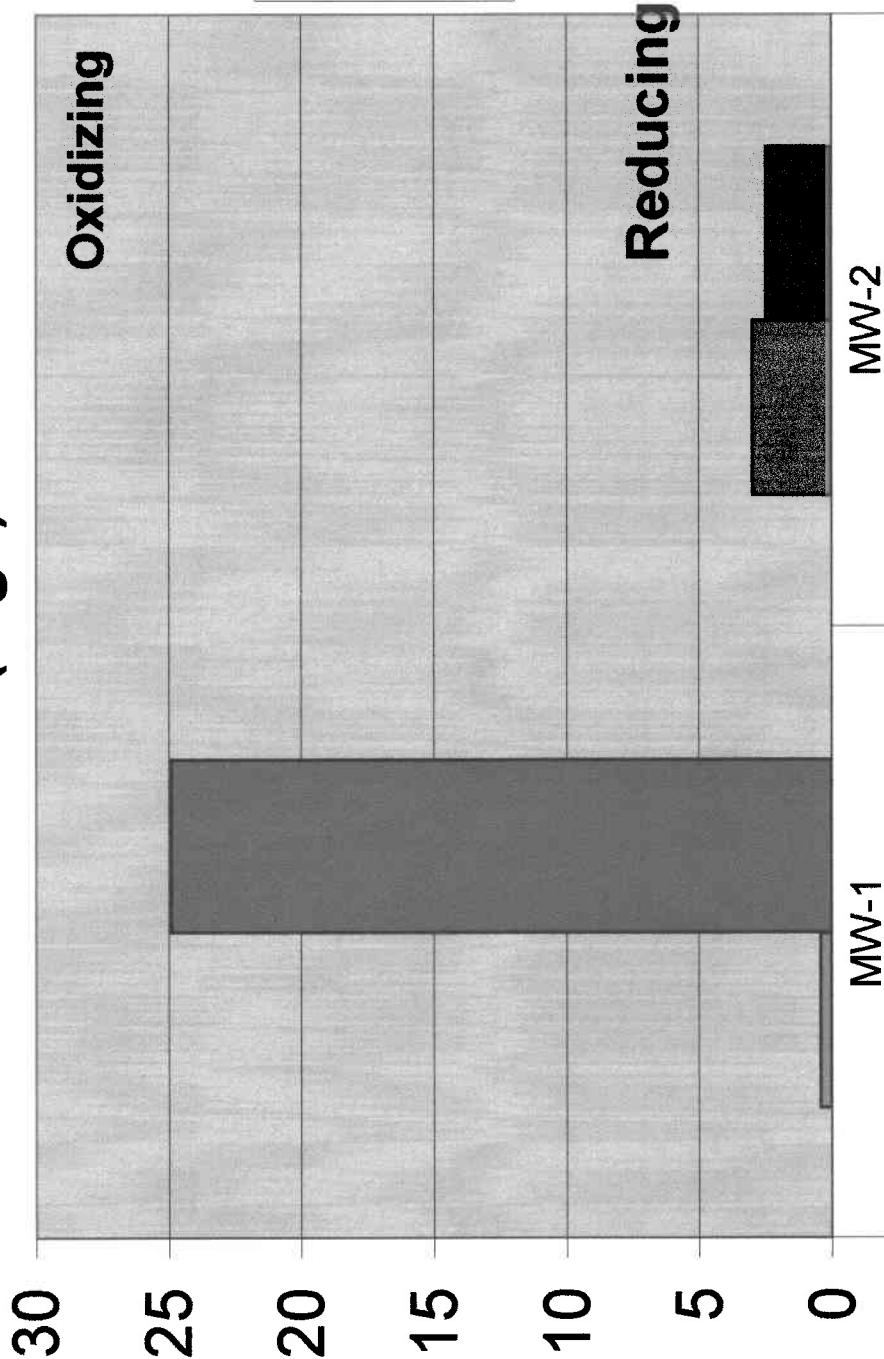
WELL	DATE	Ammonia as Nitrogen (mg/l) nutrient	o-Phosphate (mg/l) nutrient	Biochemical Oxygen Demand (BOD) (mg/l)	Chemical Oxygen Demand (COD) (mg/l)	Total Dissolved Solids (mg/l)	Total Inorganic Carbon (as Carbon) (mg/l)	Total Inorganic Carbon (calc) (mg/l)	Sulfate (mg/l)	Nitrate (as N) (mg/l)
MW-1	8/4/2004	ND	ND	30	110	170	22.2	NA	3.1	ND
MW-1	4/18/2005	ND	ND	ND	57	170	10.3	NA	18	58
MW-2	8/4/2004	ND	ND	NA	NA	NA	10.4	NA	NA	NA
MW-2	4/18/2005	ND	ND	ND	ND	220	28.1	NA	22	57

WELL	DATE	Total Iron Fe (mg/l); Field Test	Ferrous Iron Fe ²⁺ (mg/l); Field Test	Ferric Iron Fe ³⁺ (mg/l) by subtraction	Fe ²⁺ /Fe total calculation	Dissolved Oxygen mg/l Field Test	Oxidation Reduction Potential (ORP) (mV) Field Test	pH Field Test	TPH-gasoline ug/l	Benzene ug/l
MW-1	8/4/2004	4.2	3.2	1.0	76%	0.4	63	6.59	18000*	880*
MW-1	4/18/2005	2.2	0.4	1.8	18%	24.9	58	5.7	<50	<0.50
MW-2	8/4/2004	0.4	0.0	0.4	0%	3	81	7.43	<50*	<0.50*
MW-2	4/18/2005	0.2	0.0	-	-	2.5	45	6.24	<50	<0.50

NOTES:
mg/L: milligrams per liter.
ND: Not detected above the laboratory reporting limit (see laboratory reports for reporting limits).
NA: Not analyzed
calc: Calculation performed in the laboratory

AE001D Seymour / Rio Dell, CA

DO (mg/l)



DO (8/4/04)
DO (4/18/05)

DO (8/4/04)
DO (4/18/05)

MW-2

MW-1

3.0

2.5

0.4

24.9

Oxidizing

Reducing

AE001D Seymour / Rio Dell, CA

ORP (mV)

400
300
200
100
0
-100
-200
-300
-400

Oxidizing

Reducing

- ◆ ORP (8/4/04)
- ORP (4/18/05)

MW-1

MW-2

- ◆ ORP (8/4/04)
- ORP (4/18/05)

81

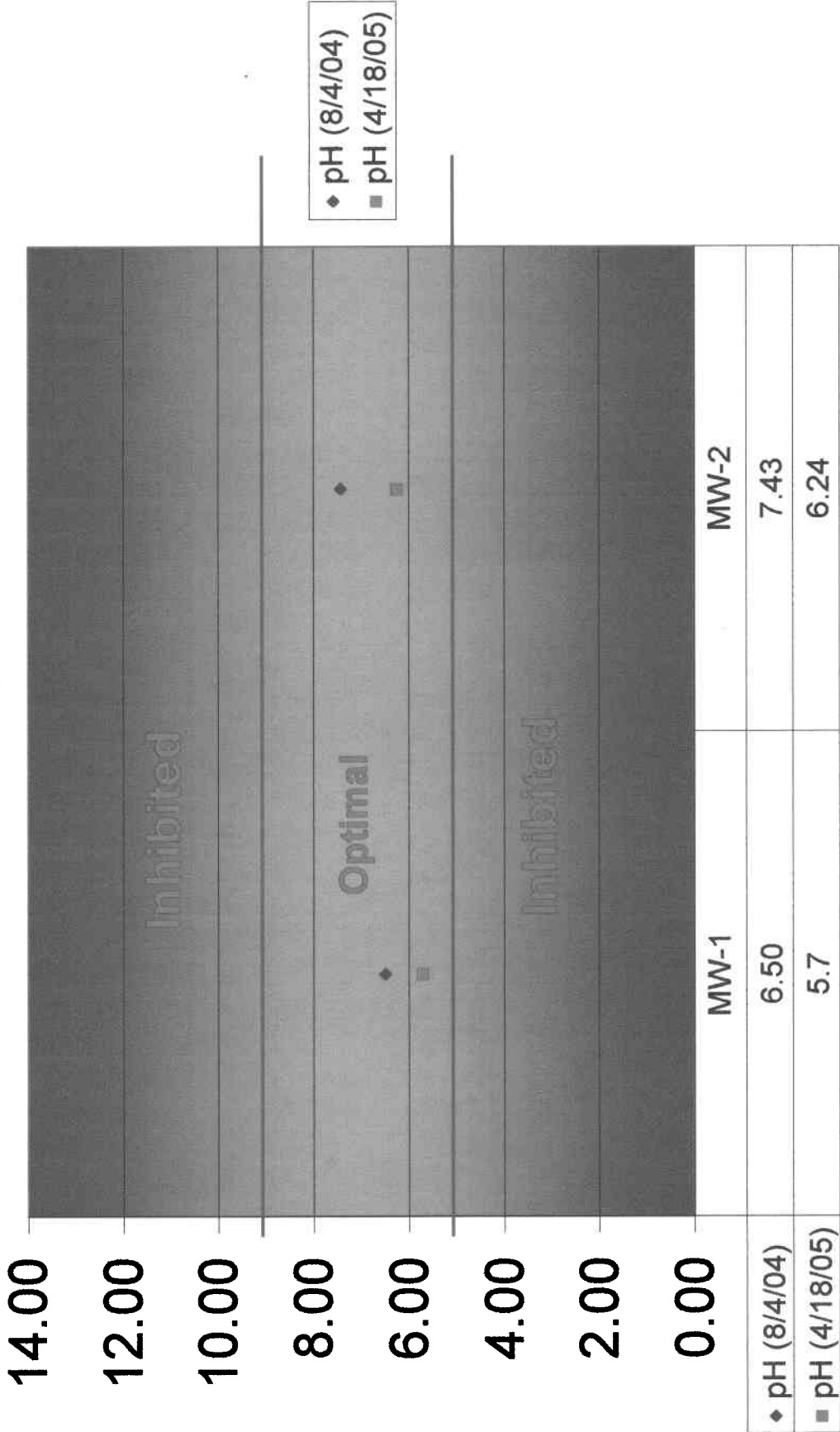
45

63

58

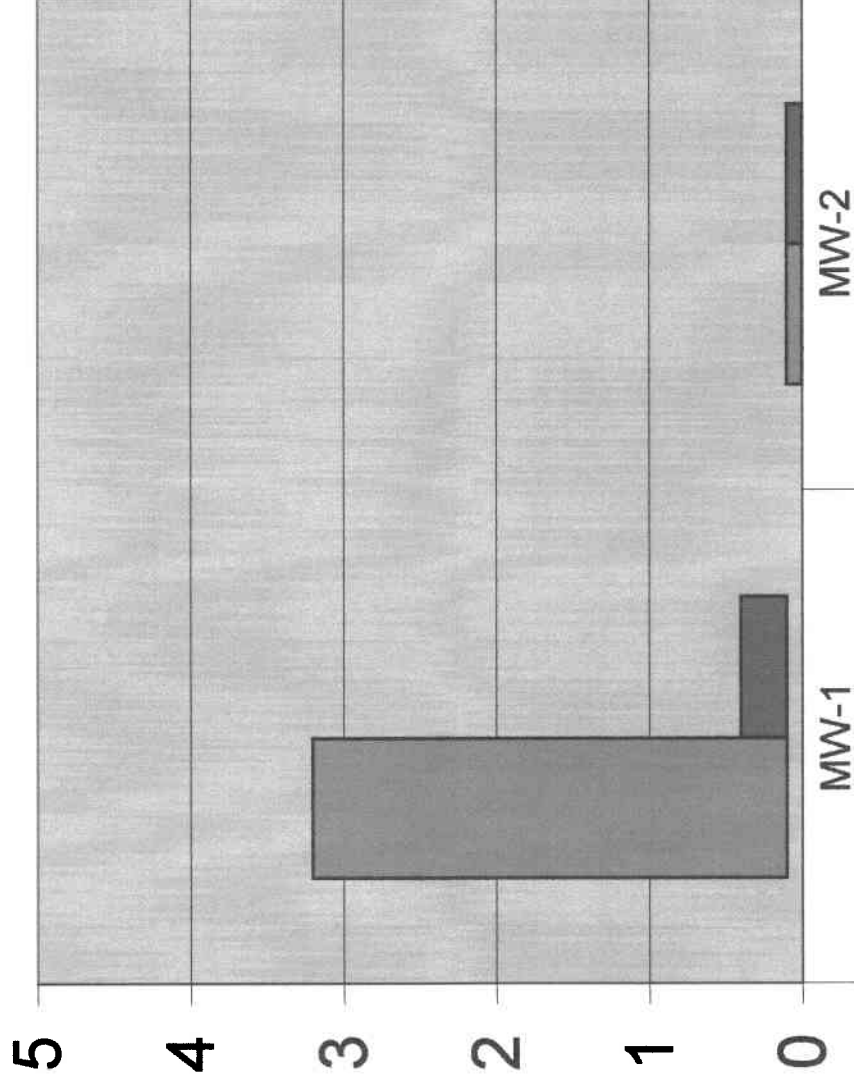
AE001D Seymour / Rio Dell, CA

pH (mg/L)



AE001D; Seymour / Rio Dell, CA

Ferrous Iron (reduced) (mg/l)



■ Ferrous Iron
(8/4/04)

■ Ferrous Iron
(4/18/04)

"0" for MW-2 =
was not analyzed 8-
4-04.

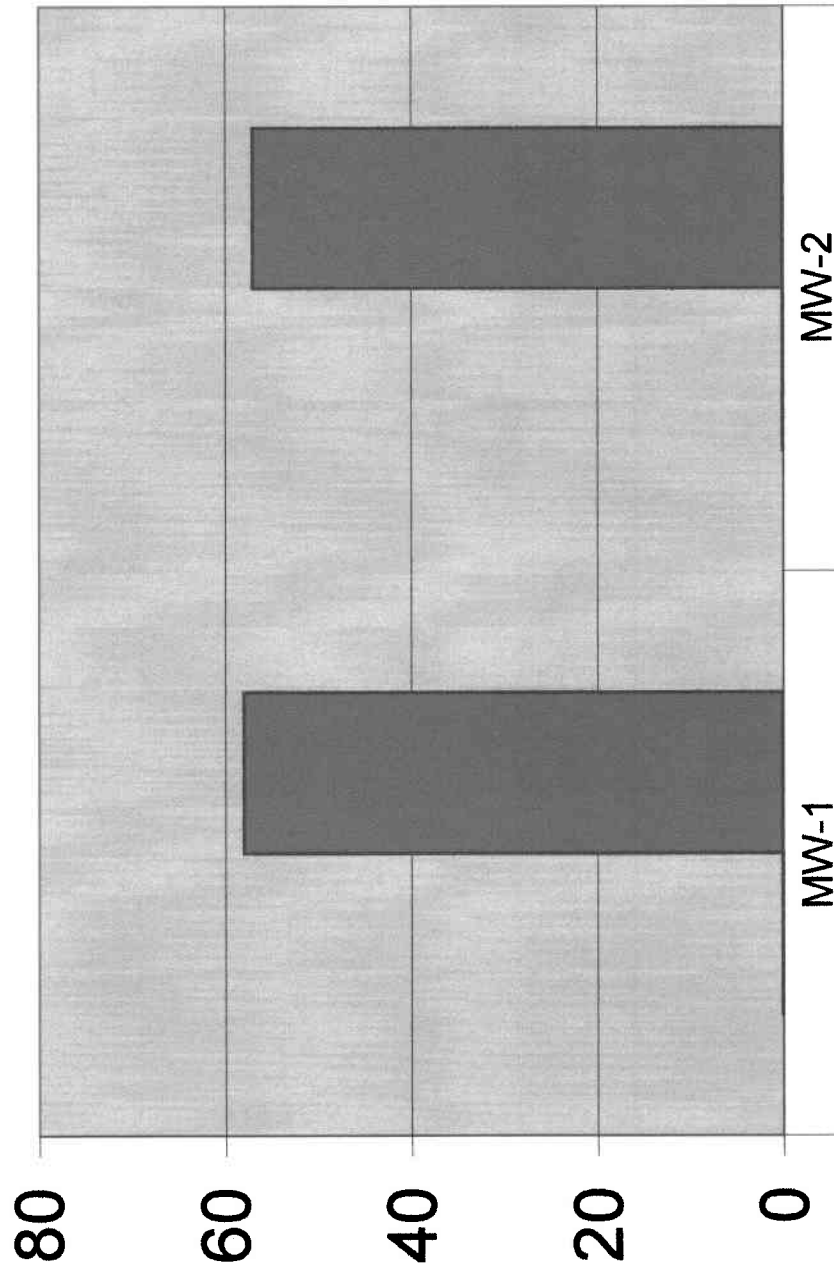
Conc. (mg/l)

■ Ferrous Iron (8/4/04)

■ Ferrous Iron (4/18/04)

AE001D; Seymour / Rio Dell, CA

Nitrate (mg/l)



■ Nitrate(8/4/04)

■ Nitrate (4/18/05)

"0" for MW-1 is below detection levels, for MW-2 it was not analyzed 8-4-04.

**Conc.
(mg/l)**

■ Nitrate(8/4/04)

■ Nitrate (4/18/05)

0

58

MW-1

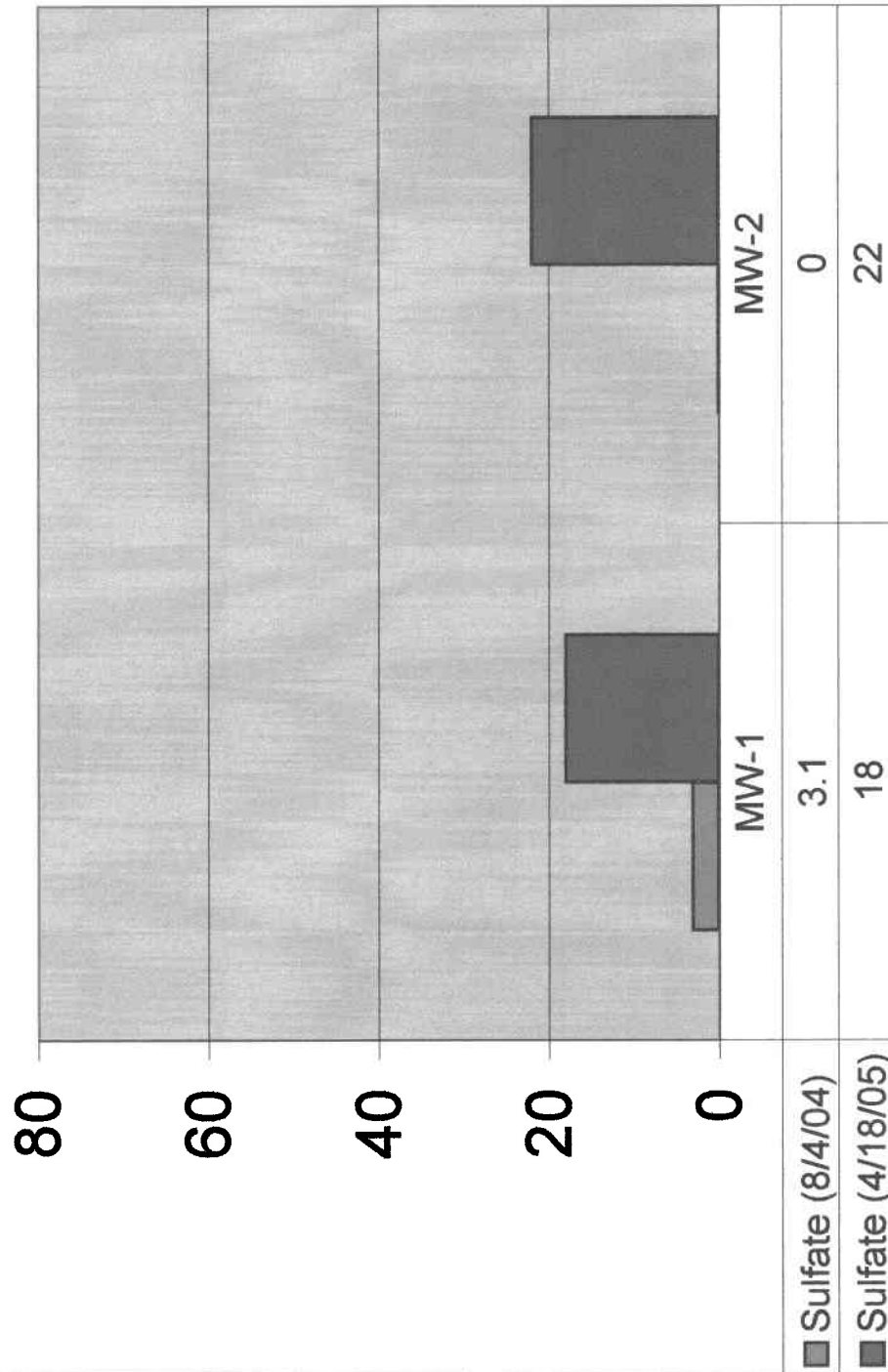
0

57

MW-2

AE001D; Seymour / Rio Dell, CA

Sulfate (mg/l)



■ Sulfate (8/4/04)

■ Sulfate (4/18/05)

"0" for MW-2 =
was not analyzed 8-
4-04.

Conc. (mg/l)



alpha

Alpha Analytical Laboratories Inc.

e-mail: clientservices@alpha-labs.com • Phone: (707) 468-0401 • Fax: (707) 468-5267

208 Mason St. Ukiah, California 95482

02 May 2005

Clearwater Group

Attn: Matthew Rider Smith

229 Tewksbury Ave.

Point Richmond, CA 94801

RE: Seymour - Rio Dell, Ca

Work Order: A504515

Enclosed are the results of analyses for samples received by the laboratory on 04/19/05 15:20. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Sheri Speaks

Sheri L. Speaks
Project Manager



alpha

Alpha Analytical Laboratories Inc.

e-mail: clientservices@alpha-labs.com • Phone: (707) 468-0401 • Fax: (707) 468-5267

208 Mason St. Ukiah, California 95482

CHEMICAL EXAMINATION REPORT

Page 1 of 9

Clearwater Group
229 Tewksbury Ave.
Point Richmond, CA 94801
Attn: Matthew Rider Smith

Report Date: 05/02/05 12:46
Project No: AE001E
Project ID: Seymour - Rio Dell, Ca

Order Number
A504515

Receipt Date/Time
04/19/2005 15:20

Client Code
CWGROUP

Client PO/Reference

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
MW-1	A504515-01	Water	04/18/05 18:00	04/19/05 15:20
MW-2	A504515-02	Water	04/18/05 18:15	04/19/05 15:20

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Sheri Speaks

Sheri L. Speaks
Project Manager

5/2/2005



Alpha Analytical Laboratories Inc.

208 Mason St. Ukiah, California 95482

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CHEMICAL EXAMINATION REPORT

Page 2 of 9

Clearwater Group
229 Tewksbury Ave.
Point Richmond, CA 94801
Attn: Matthew Rider Smith

Report Date: 05/02/05 12:46
Project No: AE001E
Project ID: Seymour - Rio Dell, Ca

Order Number
A504515

Receipt Date/Time
04/19/2005 15:20

Client Code
CWGROUP

Client PO/Reference

Alpha Analytical Laboratories, Inc.

	METHOD	BATCH	PREPARED	ANALYZED	DILUTION	RESULT	PQL	NOTE
MW-1 (A504515-01)			Sample Type: Water			Sampled: 04/18/05 18:00		
Conventional Chemistry Parameters by APHA/EPA Methods								
Ammonia as N	SM4500NH3C	AD52611	04/29/05	04/29/05	1	ND mg/l	0.20	
Biochemical Oxygen Demand	SM5210B	AD52013	04/20/05	04/25/05	"	ND "	5.0	
Chemical Oxygen Demand	SM5220D	AD52007	04/20/05	04/21/05	"	57 "	10	
pH	EPA 150.1	AD51912	04/19/05	04/19/05	"	6.6 pH Units	1.0	
Total Alkalinity as CaCO3	SM2320B	"	"	"	"	39 mg/l	5.0	
Total Dissolved Solids	EPA 160.1	AD52513	04/25/05	04/28/05	"	170 "	10	
Carbonate Alkalinity as CaCO3	SM2320B	AD51912	04/19/05	04/19/05	"	ND "	5.0	
Total Inorganic Carbon	EPA 415.1	AD52706	04/27/05	04/28/05	"	10.3 "	5.00	
Total Organic Carbon	"	AD52104	04/22/05	04/26/05	"	1.22 "	1.00	
Bicarbonate Alkalinity as CaCO3	SM2320B	AD51912	04/19/05	04/19/05	"	39 "	5.0	
Hydroxide Alkalinity as CaCO3	"	"	"	"	"	ND "	5.0	
Anions by EPA Method 300.0								
Nitrate as NO3	EPA 300.0	AD51907	04/19/05	04/19/05	2	58 mg/l	2.0	
Orthophosphate	"	"	"	04/19/05	1	ND "	0.30	
Sulfate as SO4	"	"	"	"	"	18 "	0.50	
MW-2 (A504515-02)			Sample Type: Water			Sampled: 04/18/05 18:15		
Conventional Chemistry Parameters by APHA/EPA Methods								
Ammonia as N	SM4500NH3C	AD52611	04/29/05	04/29/05	1	ND mg/l	0.20	
Biochemical Oxygen Demand	SM5210B	AD52013	04/20/05	04/25/05	"	ND "	5.0	
Chemical Oxygen Demand	SM5220D	AD52007	04/20/05	04/21/05	"	ND "	10	
pH	EPA 150.1	AD51912	04/19/05	04/19/05	"	6.5 pH Units	1.0	
Total Alkalinity as CaCO3	SM2320B	"	"	"	"	87 mg/l	5.0	
Total Dissolved Solids	EPA 160.1	AD52513	04/25/05	04/28/05	"	220 "	10	
Carbonate Alkalinity as CaCO3	SM2320B	AD51912	04/19/05	04/19/05	"	ND "	5.0	
Total Inorganic Carbon	EPA 415.1	AD52706	04/27/05	04/28/05	"	28.1 "	5.00	
Total Organic Carbon	"	AD52104	04/22/05	04/26/05	"	ND "	1.00	
Bicarbonate Alkalinity as CaCO3	SM2320B	AD51912	04/19/05	04/19/05	"	87 "	5.0	
Hydroxide Alkalinity as CaCO3	"	"	"	"	"	ND "	5.0	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Sheri Speaks

Sheri L. Speaks
Project Manager

5/2/2005



alpha

Alpha Analytical Laboratories Inc.

e-mail: clientservices@alpha-labs.com • Phone: (707) 468-0401 • Fax: (707) 468-5267

208 Mason St. Ukiah, California 95482

CHEMICAL EXAMINATION REPORT

Page 3 of 9

Clearwater Group
229 Tewksbury Ave.
Point Richmond, CA 94801
Attn: Matthew Rider Smith

Report Date: 05/02/05 12:46
Project No: AE001E
Project ID: Seymour - Rio Dell, Ca

Order Number
A504515

Receipt Date/Time
04/19/2005 15:20

Client Code
CWGROUP

Client PO/Reference

Alpha Analytical Laboratories, Inc.

METHOD	BATCH	PREPARED	ANALYZED	DILUTION	RESULT	PQL	NOTE
--------	-------	----------	----------	----------	--------	-----	------

MW-2 (A504515-02)

Sample Type: Water

Sampled: 04/18/05 18:15

Anions by EPA Method 300.0

Nitrate as NO3	EPA 300.0	AD51907	04/19/05	04/19/05	2	57 mg/l	2.0
Orthophosphate	"	"	"	04/19/05	1	ND "	0.30
Sulfate as SO4	"	"	"	"	"	22 "	0.50

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Sheri L. Speaks

Sheri L. Speaks
Project Manager

5/2/2005



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Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control

Analyte(s)	Result	PQL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch AD51912 - General Preparation										
Duplicate (AD51912-DUP1)		Source: A504485-01			Prepared & Analyzed: 04/19/05					
Total Alkalinity as CaCO ₃	250	5.0	mg/l		260			3.92	20	
pH	7.80	1.0	pH Units		7.8			0.00	20	
Carbonate Alkalinity as CaCO ₃	ND	5.0	mg/l		ND				20	
Bicarbonate Alkalinity as CaCO ₃	250	5.0	"		260			3.92	20	
Hydroxide Alkalinity as CaCO ₃	ND	5.0	"		ND				20	
Batch AD52007 - General Preparation										
Blank (AD52007-BLK1)		Prepared: 04/20/05 Analyzed: 04/21/05								
Chemical Oxygen Demand	ND	10	mg/l							
LCS (AD52007-BS1)		Prepared: 04/20/05 Analyzed: 04/21/05								
Chemical Oxygen Demand	99.8	10	mg/l	100		99.8	85-115			
LCS Dup (AD52007-BSD1)		Prepared: 04/20/05 Analyzed: 04/21/05								
Chemical Oxygen Demand	103	10	mg/l	100		103	85-115	3.16	20	
Duplicate (AD52007-DUP1)		Source: A504423-01			Prepared: 04/20/05 Analyzed: 04/21/05					
Chemical Oxygen Demand	ND	10	mg/l		ND				20	
Matrix Spike (AD52007-MS1)		Source: A504423-01			Prepared: 04/20/05 Analyzed: 04/21/05					
Chemical Oxygen Demand	404	10	mg/l	400	ND	101	85-115			
Matrix Spike Dup (AD52007-MSD1)		Source: A504423-01			Prepared: 04/20/05 Analyzed: 04/21/05					
Chemical Oxygen Demand	405	10	mg/l	400	ND	101	85-115	0.247	20	

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Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control

Analyte(s)	Result	PQL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch AD52013 - General Preparation										
Blank (AD52013-BLK1)				Prepared: 04/20/05 Analyzed: 04/25/05						
Biochemical Oxygen Demand	ND	5.0	mg/l							
Blank (AD52013-BLK2)				Prepared: 04/20/05 Analyzed: 04/25/05						
Biochemical Oxygen Demand	ND	5.0	mg/l							
LCS (AD52013-BS1)				Prepared: 04/20/05 Analyzed: 04/25/05						
Biochemical Oxygen Demand	197	5.0	mg/l	200		98.5	80-120			
LCS Dup (AD52013-BSD1)				Prepared: 04/20/05 Analyzed: 04/25/05						
Biochemical Oxygen Demand	197	5.0	mg/l	200		98.5	80-120	0.00	20	
Batch AD52104 - General Prep										
Blank (AD52104-BLK1)				Prepared: 04/22/05 Analyzed: 04/25/05						
Total Organic Carbon	ND	1.00	mg/l							
LCS (AD52104-BS1)				Prepared: 04/22/05 Analyzed: 04/25/05						
Total Organic Carbon	9.92	1.00	mg/l	10.0		99.2	85-115			
LCS Dup (AD52104-BSD1)				Prepared: 04/22/05 Analyzed: 04/25/05						
Total Organic Carbon	9.89	1.00	mg/l	10.0		98.9	85-115	0.303	20	
Duplicate (AD52104-DUP1)				Source: A504421-01 Prepared: 04/22/05 Analyzed: 04/26/05						
Total Organic Carbon	108	20.0	mg/l		111			2.74	20	
Matrix Spike (AD52104-MS1)				Source: A504464-01 Prepared: 04/22/05 Analyzed: 04/26/05						
Total Organic Carbon	321	20.0	mg/l	200	112	104	70-130			

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Project ID: Seymour - Rio Dell, Ca

Order Number	Receipt Date/Time	Client Code	Client PO/Reference
A504515	04/19/2005 15:20	CWGROU	

Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control

Analyte(s)	Result	PQL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch AD52104 - General Prep										
Matrix Spike Dup (AD52104-MSD1)				Source: A504464-01		Prepared: 04/22/05 Analyzed: 04/26/05				
Total Organic Carbon	327	20.0	mg/l	200	112	108	70-130	1.85	20	
Batch AD52513 - General Preparation										
Blank (AD52513-BLK1)				Prepared: 04/25/05 Analyzed: 04/28/05						
Total Dissolved Solids	ND	10	mg/l							
LCS (AD52513-BS1)				Prepared: 04/25/05 Analyzed: 04/28/05						
Total Dissolved Solids	474	10	mg/l	447		106	80-120			
Duplicate (AD52513-DUP1)				Source: A504558-02		Prepared: 04/25/05 Analyzed: 04/28/05				
Total Dissolved Solids	1240	10	mg/l		1300			4.72	30	
Batch AD52611 - General Preparation										
Blank (AD52611-BLK1)				Prepared: 04/05/05 Analyzed: 04/26/05						
Ammonia as N	ND	0.20	mg/l							
LCS (AD52611-BS1)				Prepared & Analyzed: 04/26/05						
Ammonia as N	8.06	0.20	mg/l	8.00		101	90-110			
LCS Dup (AD52611-BSD1)				Prepared & Analyzed: 04/26/05						
Ammonia as N	7.99	0.20	mg/l	8.00		99.9	90-110	0.872	10	
Batch AD52706 - General Prep										
Blank (AD52706-BLK1)				Prepared: 04/27/05 Analyzed: 04/28/05						
Total Inorganic Carbon	ND	5.00	mg/l							

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A504515

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Conventional Chemistry Parameters by APHA/EPA Methods - Quality Control

Analyte(s)	Result	PQL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch AD52706 - General Prep										
LCS (AD52706-BS1)				Prepared: 04/27/05 Analyzed: 04/28/05						
Total Inorganic Carbon	55.7	5.00	mg/l	50.0		111	85-115			
LCS Dup (AD52706-BSD1)				Prepared: 04/27/05 Analyzed: 04/28/05						
Total Inorganic Carbon	57.0	5.00	mg/l	50.0		114	85-115	2.31	20	
Duplicate (AD52706-DUP1)				Source: A504515-01 Prepared: 04/27/05 Analyzed: 04/28/05						
Total Inorganic Carbon	10.1	5.00	mg/l		10.3			1.96	20	
Matrix Spike (AD52706-MS1)				Source: A504515-02 Prepared: 04/27/05 Analyzed: 04/28/05						
Total Inorganic Carbon	147	10.0	mg/l	100	28.1	119	70-130			
Matrix Spike Dup (AD52706-MSD1)				Source: A504515-02 Prepared: 04/27/05 Analyzed: 04/28/05						
Total Inorganic Carbon	147	10.0	mg/l	100	28.1	119	70-130	0.00	20	

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Anions by EPA Method 300.0 - Quality Control

Analyte(s)	Result	PQL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Flag
Batch AD51907 - General Preparation										
Blank (AD51907-BLK1)				Prepared & Analyzed: 04/19/05						
Nitrate as NO ₃	ND	1.0	mg/l							
Orthophosphate	ND	0.30	"							
Sulfate as SO ₄	ND	0.50	"							
LCS (AD51907-BS1)				Prepared & Analyzed: 04/19/05						
Nitrate as NO ₃	4.2	1.0	mg/l	4.43		94.8	90-110			
Orthophosphate	5.49	0.30	"	6.00		91.5	90-110			
Sulfate as SO ₄	8.13	0.50	"	8.00		102	90-110			
LCS Dup (AD51907-BSD1)				Prepared & Analyzed: 04/19/05						
Nitrate as NO ₃	4.2	1.0	mg/l	4.43		94.8	90-110	0.00	20	
Orthophosphate	5.58	0.30	"	6.00		93.0	90-110	1.63	20	
Sulfate as SO ₄	8.04	0.50	"	8.00		100	90-110	1.11	10	
Duplicate (AD51907-DUP1)				Source: A504483-02 Prepared & Analyzed: 04/19/05						
Nitrate as NO ₃	ND	4.0	mg/l		ND				20	
Orthophosphate	ND	1.2	"		ND				20	
Sulfate as SO ₄	14.3	2.0	"		15			4.78	20	
Matrix Spike (AD51907-MS1)				Source: A504483-02 Prepared & Analyzed: 04/19/05						
Nitrate as NO ₃	45	4.0	mg/l	44.4	ND	101	80-120			
Sulfate as SO ₄	55.6	2.0	"	40.0	15	102	80-120			
Orthophosphate	57.6	1.2	"	60.0	ND	95.9	80-120			
Matrix Spike Dup (AD51907-MSD1)				Source: A504483-02 Prepared & Analyzed: 04/19/05						
Nitrate as NO ₃	45	4.0	mg/l	44.4	ND	101	80-120	0.00	20	
Sulfate as SO ₄	55.6	2.0	"	40.0	15	102	80-120	0.00	10	
Orthophosphate	59.2	1.2	"	60.0	ND	98.6	80-120	2.74	20	

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Project ID: Seymour - Rio Dell, Ca

Order Number
A504515

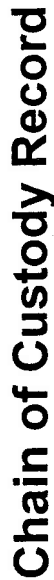
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Client Code
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Notes and Definitions

DET Analyte DETECTED
ND Analyte NOT DETECTED at or above the reporting limit
NR Not Reported
dry Sample results reported on a dry weight basis
RPD Relative Percent Difference
PQL Practical Quantitation Limit



Chain of Custody Record

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Cyto Culture

ENVIRONMENTAL
BIOTECHNOLOGY

CytoCulture International, Inc.
249 Tewksbury Avenue
Pt. Richmond, CA 94801 USA

Clearwater Group

Project Name: **Seymour**

Project number: **AE001D**

Project Manager: **M. Ryder-Smith**

Address: 229 Tewksbury Ave.

Point Richmond, CA 94801

Tel: 510 307-9943 x 222 Fax: 510 232-2823

Reporting date: **May 2, 2005**

CytoCulture lab login: **05-46**

Samples: Two water samples packed on ice were received 04/22/05. The samples were stored at 4°C and assayed on the same day. Please see the attached chain of custody form.

AEROBIC

Hydrocarbon-Degrading and Total Heterotrophic Bacteria Enumeration Assays

Analysis Request: Enumeration of aerobic gasoline hydrocarbon-degrading bacteria and aerobic total heterotrophic bacteria by method 9215A (HPC)/ Standard Methods 9215B modified.

Carbon Source for Hydrocarbon-Degrading Bacteria: Pasteurized Chevron regular gasoline and diesel No. 2 were dissolved into agar plates as the sole carbon and energy source for the growth of aerobic hydrocarbon-degrading bacteria.

Protocol for Hydrocarbon-Degrading Bacteria: Sterile agar plates (100 x 15 mm) were prepared with minimal salts medium at pH 6.8 with agar and hydrocarbons, without any other carbon sources or nutrients added. Sets of triplicate plates were inoculated with 1.0 ml of each sample (log dilution 10^0) and log dilutions of each sample at 10^{-1} , 10^{-2} , and 10^{-3} . Hydrocarbon plates were counted after 9 days incubation at 30°C. The plate count data is reported as colony forming units (cfu) per milliliter (ml). Each enumeration value represents a statistical average of the plate count data obtained from two of the four inoculating log dilutions assayed.

Carbon Source for Total Heterotrophic Bacteria: Growth medium was prepared with standard methods total plate count agar (Difco) containing a wide range of carbon sources derived from yeast extract, tryptone, pancreatic digest of casein and glucose.

Protocol for Total Heterotrophic Bacteria: Sterile agar plates (100 x 15 mm) were prepared with minimal salts and 2.35% heterotrophic plate count agar at pH 6.8 without any other carbon source or nutrients added. Sets of triplicate plates were inoculated with 1.0 ml of sample at log

dilutions 10^{-1} , 10^{-2} , and 10^{-3} . The heterotrophic plates were counted after 4 days incubation at 30°C. The plate count data is reported as colony forming units (cfu) per milliliter (ml) of sample. Each enumeration value represents a statistical average of two of the four inoculating log dilutions assayed.

AEROBIC Hydrocarbon-Degrading Bacteria Enumeration Results

Client Sample Number	Sample Date	Hydrocarbon Degradors (cfu/ml)	Target Hydrocarbons Tested	Total Heterotrophs (cfu/ml)
MW-1	04/18/05	2×10^4	Gasoline/Diesel	3×10^4
MW-3	04/18/05	3×10^3	Gasoline/Diesel	2×10^4
Sterile Water	04/22/05	0	Gasoline/Diesel	0
Air Control	04/22/05	0	Gasoline/Diesel	0
Positive Control	04/22/05	5×10^8	Gasoline/Diesel	5×10^9

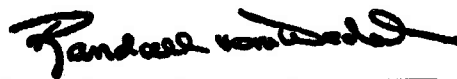
Reporting Limit for enumeration data is 1.0×10^1 cfu/ml.

A hydrocarbon-degrading bacteria positive control sample was run concurrently with each set of samples using a mixed flask culture of bacteria enriched from contaminated UST sites in Northern California.

CytoCulture is available on a consulting basis to assist in the interpretation of these data and their application to field bioremediation protocols.



Sharon Huang
Laboratory Technician



Randall von Wedel, Ph.D.
Principal Biochemist

05-46

Clearwater GroupSubcontracted Microbiology Assays
performed by

CytoCulture Environmental Biotechnology

CHAIN OF CUSTODY FORM

Project Name: <i>Seymour</i>	Project No. <i>AE001D</i>	Clearwater Purchase Order / LOG IN #:
Clearwater Client Organization:		Clearwater Project Manager: <i>M. Ryder-Smith</i>
Address to Send Results:		
Client Fax for Sending Data: <i>510 232 2823</i>		Client Contact / Project Manager: <i>M. Ryder-Smith</i>
Client Tel for Follow-up: <i>510 307 9943 x222</i>		Client Sampler / Recorder: <i>R. Berry</i>

Sample ID	Sampling		Matrix		Bacterial Plate			Bacterial MPN			Nutrient / Chemical										
	Date	Time	Soil	Water	Aerobic Hydrocarbon Degraders	Total Heterotrophs	Anaerobic Hydrocarbon Degraders	Total Heterotrophs	Anaerobic Nitrate Reducers	Iron Reducers	Sulfate Reducers	pH	mV	DO	NH3	PO4	NO3	SO4	Sulfide	Fe(II)	Fe(III)
MW-1	04/18/05			✓	✓	✓															
MW-2	04/18/05			✓	✓	✓															

Chain of Custody Record	Signature of this form constitutes a firm Purchase Order for services.	Payment DUE on Reporting Date.
Relinquished by: <i>[Signature]</i>	Received by:	Date/Hr:
Received for CytoCulture Lab by: <i>[Signature]</i>		
	CytoCulture Tel: 510-233-0102	249 Tewksbury Avenue
	Lab Service Fax: 510-233-3777	Point Richmond, CA 94801

AEROBIC NATURAL ATTENUATION STUDY

Typical contaminants: TPH (gas, diesel, motor oil, etc., BTEX, MTBE, vinyl chloride)

<u>Biological Analysis Description</u>	<u>EPA Method</u>	<u>Matrix</u>	<u>Bottle</u>	<u>Preservative</u>
Specific Degradors: Aerobic petroleum hydrocarbon-degrading bacteria	9215A (HPC)/ SM9215B modified	aqueous	1 pt HDPE plastic	None
Total Heterotrophic bacteria	9215A (HPC)/ SM9215B modified	aqueous	1 pt HDPE plastic	None

<u>Chemical Analysis Description</u>	<u>Method</u>	<u>Matrix</u>	<u>Bottle</u>	<u>Preservative</u>
Biological oxygen demand (BOD: 5-day)	SM 5210B	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Alkalinity: Speciated	SM 2320B	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Total Alkalinity as CaCO ₃	SM 2320B	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Carbonate Alkalinity as CaCO ₃	SM 2320B	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Bicarbonate Alkalinity as CaCO ₃	SM 2320B	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Hydroxide Alkalinity as CaCO ₃	SM 2320B	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Ortho-phosphate	EPA 300.0	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Nitrate as NO ₃	EPA 300.0	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Sulfate as SO ₄	EPA 300.0	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Total Dissolved Solids (TDS)	EPA 160.1	aqueous	1 L (or 1/2 gal.) HDPE plastic	None
Ammonia as nitrogen	SM 4500NH3C	aqueous	1 L (or 1/2 gal.) HDPE plastic	H ₂ SO ₄
Total Organic Carbon (TOC)	EPA 415.1	aqueous	125 ml amber glass	HCl
Total Inorganic Carbon (TIC)	EPA 415.1	aqueous	125 ml amber glass	HCl
Chemical Oxygen Demand (COD)	SM 5220D	aqueous	1 pt. HDPE plastic	H ₂ SO ₄

<u>Field Measurements Description</u>	<u>Method</u>	<u>Matrix</u>	<u>Bottle</u>	<u>Preservative</u>
Dissolved Oxygen (DO)	Point Four downhole DO Meter	aqueous	1 pt. HDPE plastic	None
Oxidation-Reduction Potential (ORP)	Point Four downhole ORP Meter	aqueous	1 pt. HDPE plastic	None
pH	Field Meter	aqueous	1 pt. HDPE plastic	None
Temperature	Field Meter	aqueous	1 pt. HDPE plastic	None
Total iron	colorimetric	aqueous	1 pt. HDPE plastic	None
Fe+2 (Ferrous iron = reduced)	colorimetric	aqueous	1 pt. HDPE plastic	None
Fe+3 (Ferric iron = oxidized) by calc.	calculation	NA	NA	NA
Dissolved Carbon Dioxide (CO ₂) by calc.	calculation	NA	NA	NA

NOTES:

Most laboratory analyses on 10 day turn around time

SM = standard method

NA = not applicable

For EBS projects, EBS supplies free bottles and shipping with an order of 3 or more well samples.

ANAEROBIC NATURAL ATTENUATION STUDY: solvents, perchlorate, heavy metals, nitrate

All the same analyses, except solvent specific degraders is not performed.

Solvent specific bench tests are available: 4-6 weeks in duration